THE APPROACHING OPPOSITION OF MARS.

THE planet Mars is now a conspicuous object in the evening sky, its ruddy, brilliant disc appearing just below the great square of Pegasus, and astronomers the world over are once more seizing the opportunities presented by a favourable opposition for the further solution of the Martian enigma. The actual opposition will not take place until September 23d. 22h., or 10 a.m. on September 24, civil date.

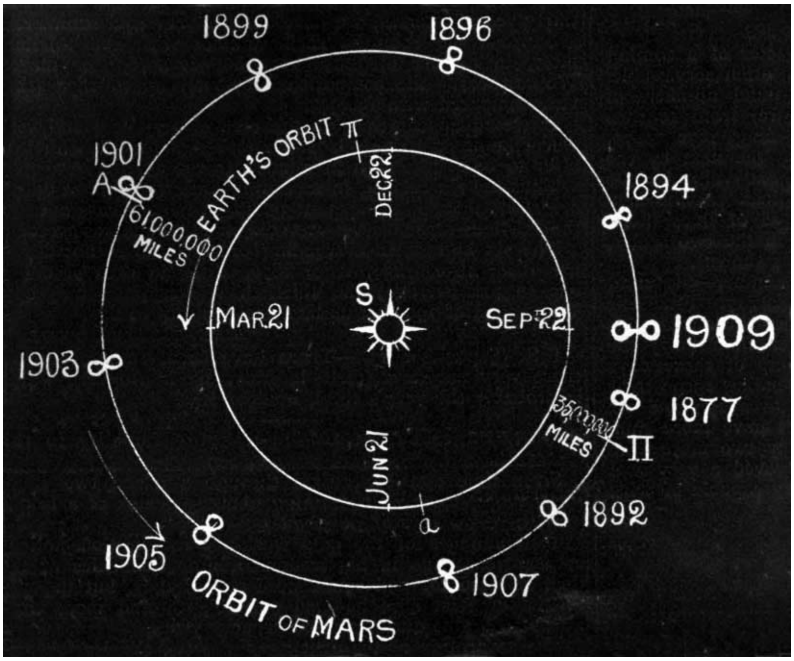

FIG. 1.

As Prof. Lowell says in his classical memoir on Mars, "Study of Mars at one opposition is material to its study at the next. . . . At any one opposition we may scan Mars but for a few months through only a fraction of its circuit round the sun." Therefore, no opportunities may be missed by the students of the ruddy planet, whenever, and under whatever conditions, an opposition takes place. But only at one opposition in every seven, or about once every fifteen years, are the conditions so favourable as at present; Figs. 1 and 2 show this diagrammatically. The orbits of the earth and Mars are drawn to scale, but as eccentric circles, and from Fig. 1 it will be seen that the opposition of this month will be, as regards the distance separating the two planets, the most favourable we have experienced since 1892. Owing to the eccentricity of the planet's orbit, the distance between the earth and Mars, when at an opposition, may range from 61,000,000 to 35,000,000 miles, the corresponding range of the apparent diameter being 13″ to 25″. The most favourable oppositions occur when Mars is near its perihelion (Π, Figs. 1 and 2), with the earth near its aphelion (*a*), point. The ideal condition would be for opposition to take place about the last week in August, whilst the most unfavourable conditions would obtain if it occurred about the third week in February; thus the opposition of 1877 was the most favourable during last century, except that of 1845, whilst that of 1901, February 21, was about as unfavourable as is possible.

The advantage of proximity was well illustrated in 1877, when Asaph Hall discovered the two Laputan satellites, and Schiaparelli first observed the much-discussed *canali*.

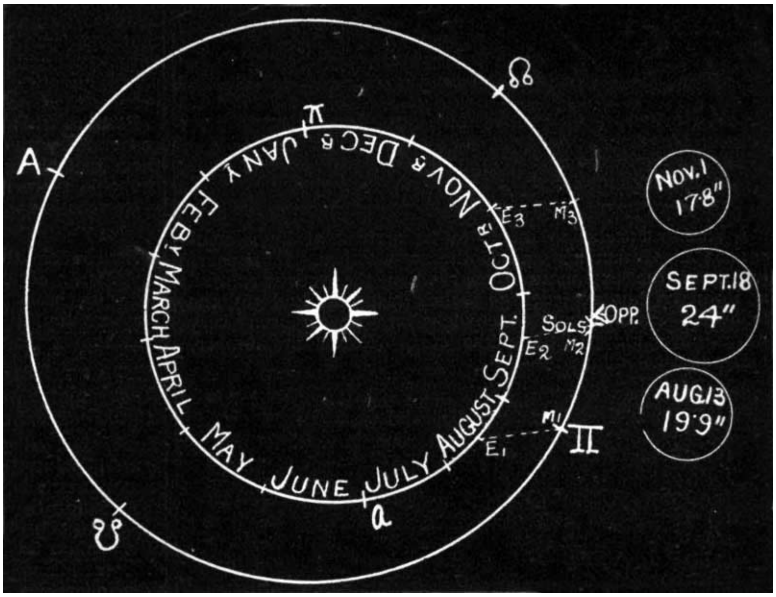

FIG. 2.

On September 23, when at opposition, Mars will be about 36·4 million miles from the earth, but the nearest approach of the two bodies will take place on September 18, when the distance separating them (E_2–M_2, Fig. 2) will be about 160,000 miles less. After the opposition, as the planet lags behind the earth, as shown in Fig. 2, the distance will continue to increase, and the apparent diameter of the planet will, of course, decrease, as shown by the circles drawn on the right of the diagram. These circles show the relative apparent diameter of the planet on August 13, when Mars is at perihelion, on September 18, when at least distance from the earth, and on November 1, when a substantial increase in the distance separating the two bodies will have taken place. The following are the apparent diameters of the planet at different epochs during the present opposition:—September 1, 22·8″; September 18, 24″; September 23 (opposition), 23·9″; October 1, 23·3″; November 1, 17·8″; December 1, 12·7″. This means that on September 18, an observer using a power of ×80 would see Mars on the same scale as a naked-eye observer sees the moon; the conditions of "seeing" would be worse. Taking another illustration, a land area of about the size of Ireland would, roughly speaking, appear as a spot of 1·3″ diameter, or a little longer than 1/1500th of the apparent diameter of the full moon.

Whilst the distance of the planet is an important factor in determining the value of the observing conditions at an opposition, it is by no means the sole factor; the altitude of the planet above the horizon makes or mars the conditions for the users of large instruments searching for minute detail. Thus, although the opposition of 1892 produced a more favourable distance-condition than that of 1894 (see Fig. 1), the observing conditions at the latter were not inferior, because of the higher culmination of the planet. At the present opposition, the declination of Mars is 4° S., and this means that for observers in our latitude (51° 30′) the meridian altitude will not exceed 35°; but this is a great improvement on the conditions in 1907, when the corresponding altitude was only 10°, and when, even from Flagstaff, Prof. Lowell found it desirable to send an expedition to the Andes for the observation of the planet. During the present opposition the meridian altitude at Flagstaff will be more than 50°.

As at all favourable oppositions, taking place about August, the south pole of Mars is now tilted earthwards, the earth, at the date of opposition, being about 20° below the plane of the planet's equator. Therefore the southern hemisphere will be observed, and as the summer solstice of this hemisphere, as shown in Fig. 2, occurs but a few days before opposition, the southern snowcap is in the process of dissolution, and changes due to the melting of the snow are taking place. Already such phenomena have been recorded by MM. Desloges and Jonckheere, among others. As the rotation-periods of the earth and Mars are approximately equal, the same regions can be observed on consecutive nights. On September 19 the Syrtis Major region will be in view, and on September 27 the region of the Mare Cimmerium.

Probably at no opposition since the time that Fontana suspected markings on the ruddy planet, in 1636, has the status of areographers been so critical as at the present juncture. Thanks to the persistent labours and unswerving faith of a few observers, of whom Prof. Lowell is the foremost, the question as to the subjective reality of the *canali* discovered by Schiaparelli in 1877 may be considered as settled. Whether one follows Prof. Lowell's lead in the matter of "artificial, irrigating waterways" or not, there can remain but little, if any, doubt that these long, straight channels do exist. In describing his observations, made at Trincomali, Ceylon, during the unfavourable opposition of 1903 (see Fig. 1), when the apparent diameter of the planet was but 14·6″, the late Major Molesworth said[1]:—"Personally, I am quite convinced of the reality of the great majority of the so-called canals: I think I could convince the most sceptical on this point if they could only have spent an hour or two at my telescope on some of the perfect nights in March and April this year." Major Molesworth used a 12¾-inch Calver reflector, with a power of 450. Numerous observers, and the Flagstaff photographs, have also testified as to the gemination of these features. Not only do these canals exist, but, in the opinion of many experienced observers, they also suffer changes which show a dependence on the seasonal changes of the planet.

Having settled the existence of the "canals," it became necessary to account for the changes, and, in one essential, this question remained more or less open until the opposition of 1907. With regard to the polar caps, Herschel's observations enforced the natural conclusion that their changes were due to the accumulation and dissipation of "snow" as the Martian winters waxed and waned. This coincidence of snowcap and season was not to be denied, and in the Martian spring, at the opposition of 1892, Prof. W. H. Pickering observed the disappearance of some 1,600,000 square miles of the southern snowcap, an area about the size of India, in a period of thirty-three days. But there still remained the one essential factor, that was the proof that this "snow" was really frozen water; that the Martian atmosphere contained water-vapour sufficient to produce these effects. On this point the different observers were at issue.

Beer and Mädler, during 1830–9, found that occasionally certain permanent features of the planet's landscape were blurred, as though by passing cloud and mist. During the favourable opposition of 1862, Lockyer's observations led to the definite conclusion that "the daily—nay, *hourly*—changes in the detail and in the tones of the different parts of the planet"[1] were caused by the transit of clouds over the various features.

"Clouds and mists" and "polar snows" inevitably suggest to the terrestrian the presence of water, hence a *raison d'être* for the canals, and the spectroscopic evidence adduced by Huggins and Vogel went to confirm the suggestion. But with the spectroscopic equipment of the Lick Observatory at their disposal, Campbell and Keeler could find no evidence for water-vapour in the planet's atmosphere, and the critics of a "terrestrial" Mars suggested that the snowcaps might be caused by the solidification and deposition of some other compound, such as carbon dioxide.

However, the spectrograms obtained by Mr. Slipher at the last opposition, 1907, afford, according to our present view, incontrovertible evidence that the atmosphere of Mars does contain a detectable quantity of water-vapour (see Nature, vol. lxxvii., p. 442, March 12, 1908). Prof. Very estimates that at the time the spectrograms were taken, the Martian atmosphere contained sufficient precipitable water to give an average layer 14 mm. deep, or about one-third or one-fourth that in the earth's atmosphere. Nor is water-vapour the only familiar atmospheric constituent which has been shown to be present by the Lowell Observatory spectra. When Mr. Slipher described[2] the 1907 spectra, he explained the difficulty of detecting the free oxygen constituent of the Martian atmosphere, viz., the probable relatively slight increase in intensity, of the oxygen bands, produced by adding the absorption of a thin (Martian) atmosphere to that of a dense (terrestrial) atmosphere, but expressed the opinion that "its detection need not be considered impossible."

A recent message from the Kiel Centralstelle, dated September 10, informs us that Prof. Very's measures of the Lowell Observatory spectrograms—which show the spectra of the moon and Mars photographed side by side when the respective objects are at equal altitudes—show that oxygen is present in the atmosphere of Mars; the relative intensification of the oxygen band *b*, in the planet's spectrum, is stated to be eight times the probable error of the measures. Therefore, although the details are yet to come, it appears fairly safe to assume that not only water-vapour, but oxygen also, exists in the Martian atmosphere.

---

[1] Monthly Notices, vol. lxv., No. 8, p. 839, 1905.

[1] Memoirs R.A.S., vol. xxxii., p. 179, 1863.

[2] *Astrophysical Journal*, vol. xxviii., p. 404, 1908.

Thus we arrive at the present opposition with the knowledge that a familiar compound, capable of forming snowcaps, of filling canals, and of being pumped in order to irrigate the pastures of a thirsty landscape, exists on Mars, and is accompanied by that element which we terrestrians look upon as another essential for the existence of animal life; and crucial difficulties in the "habitability" theory have been removed. Close, persistent, and world-wide scrutiny, at this favourable epoch, should lead to further elucidation of the enigma, and enable us to "reconstruct" a being and a vegetation capable of existing there.

An idea which has caught the popular fancy is that of signalling to Mars, but as the earth, from the planet, would be in the glare of the sun and would subtend, even at the impossible moment of opposition, an angle of less than 50″—of the same order as the apparent diameter of Jupiter at his recent opposition—to say nothing of the questionable transparency of our thicker atmosphere, this problem has not yet entered the province of practical astronomy.

WILLIAM E. ROLSTON.

POLAR EXPEDITIONS AND OBSERVATIONS.

THE position and prospects of polar exploration have been given great attention in the daily Press during the last few days. No precise information as to Dr. Cook's journey to the North Pole has yet been published, but the general narrative of Commander Peary's expedition leaves little room for doubt that Commander Peary reached the neighbourhood of the pole, and probably the pole itself, though an element of uncertainty must exist until his observations for latitude are examined critically. The Berlin correspondent of the *Times* reports that an executive committee for a Zeppelin polar expedition has been formed, the object of the expedition being defined as "the scientific investigation by means of the dirigible airship of the unknown Polar Arctic Sea and the development of the dirigible airship for the carrying out of scientific labours." Announcement has also just been made that a British Antarctic expedition will start next August under Captain R. F. Scott, who commanded the National Antarctic Expedition of 1900–4, with the object of reaching the South Pole.

As all the world knows, Mr. Shackleton's record of this year has given Great Britain the premier position in Antarctic exploration, and an earnest desire is felt by British explorers to place to the credit of this country the feat of first reaching the South Pole. McMurdo Sound has in the past been used as the base for British South Polar expeditions, but it is proposed on the next journey to establish a second base in King Edward VII. Land, 400 miles to the east of McMurdo Sound. The track to the pole from the new base may be expected to include phases similar to those met with in travelling from McMurdo Sound, but it is anticipated it will continue longer on the sea-level, meet the mountains nearer the pole, and consequently leave a shorter journey on the high inland plateau. The distance to be covered is in all some 1500 miles, for which 150 days are available. The plan for the journey to the pole from King Edward VII. Land includes the use of three means of sledge traction: ponies, a dog team with a relay of men, and motor sledges.

The scientific objects of Captain Scott's expedition are stated to be as follows:—(1) Geographical.—To explore King Edward VII. Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. (2) Geological.—To examine the entirely unknown region of King Edward VII. Land and continue the survey of the rocks of Victoria Land. (3) Meteorological.—To obtain synchronous observations at two fixed stations, as well as the weather records of sledge journeys. (4) Magnetic.—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw most important light on secular changes. (5) Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued.

It is estimated that an expedition of the kind projected will cost at least 40,000*l*., and towards this sum considerable amounts have been given already. An appeal has been made to the public, and it is hoped that no difficulty will be experienced in raising the necessary money for the accomplishment of what will in any case include valuable scientific work.

The full narrative of Commander Peary's expedition to the North Pole appeared in the *Times* of September 11 and 13, and occupied six columns. By permission of the editor we are able to give a summary of this account of the journey and the observations made. The expedition left Etah, Greenland, on August 18, 1908, in the *Roosevelt*, having on board 22 Eskimo men, 17 women, 236 dogs, and about 40 walrus. Cape Sheridan was reached on September 5 and winter quarters were established there. Sledge loads of supplies were then taken to Cape Belknap, Porter Bay and other stages up to Cape Columbia, where Prof. McMillan obtained a month of tidal observations during November and December. Tidal and meteorological observations were also made at Cape Bryant, and explorations were carried on.

The expedition started for the north from Cape Columbia in several divisions at the end of February of this year. Latitude 83° 20′ was passed on March 2, and on March 5 "the sun, red and shaped like a football by refraction, just raised itself above the horizon for a few minutes and then disappeared again." The lead, or creek of open water, which was then reached, prevented further movement until March 11, when it was frozen and a start became practicable. The depth of the lead was determined by soundings to be 110 fathoms. On March 14 the lead had been passed, and the temperature was −58° (?) F. Two days later Prof. McMillan had to be sent back to Cape Columbia at once on account of frostbite. "Sounding gave a depth of 825 fathoms. We were over the Continental Shelf, and as I had surmised, the successive leads crossed in the fifth and sixth marches composed the big lead and marked the Continental Shelf."

By an admirable system of advance, main and supporting parties, the expedition moved rapidly north, covering no fewer than fifty minutes of latitude (about 57 miles) in three marches. The fourth supporting party started on the back trail from about latitude 88°, and on April 2 Commander Peary, with his party of Eskimos, moved towards the pole.

In a march of about ten hours the party travelled twenty-five miles and was well beyond the 88th parallel, "with the sun now practically horizontal." Several long marches were accomplished, and one of forty miles in twelve hours. In four days, two degrees of latitude were covered, that is, a distance of about 138 miles. On the last stage of the journey Commander Peary's only companion was an Eskimo. An observation made on April 6 showed that the latitude was 89° 57′, so that the pole had been prac-